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A Density On-line Measurement and Control Technology of Medium Density Fiberboard(MDF)

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Abstract

Considering the present domestic situation that medium density fiberboard(MDF) plants take for destructive testing in the laboratory to do density measurement, this paper presents a density on-line measurement and control technology of MDF based on single-chip microcomputer technique. A MDF production line of some factory was actually improved using this technique. The results showed that the density could be measured dynamically, and could realize the ability of density online detection of MDF and control the density within the specified scope.

Keywords:medium density fiberboard (MDF); density; Single-Chip Microcomputer (SCM); on-line measurement and control

1.Foreword

Medium density fiberboard has been developed rapidly since its advent because of its excellent properties and wide application area [1-2]. Density is the important indicator to measure the performance of density fiberboard, however, it is very difficult for the precise measurement and control of density in the MDF manufacturing process, and on-line real-time detection and control of the density is widely used in the advanced production line [3-6]. Basically there is no density on-line detection equipment in domestic factories. Destructive test method is taken to do density detection in the laboratory, and the entire MDF is cut into a test sample to do weight and volume measurement, and then density is calculated. This method has prodigious drawbacks mainly in two ways. First, it is a kind of labor-intensive test, and the product process relies on the test results but the test results have a long time lag, so a considerable number of products have been produced during the period of the adjustment process. Second, the kind of density detection is based on a random sample, it is not possible to test each plate, therefore, the density can not be adjusted in time when the materials technology and environmental changes. In recent years, individual production lines have been equipped with homebred density instrument, the corresponding detection

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principle is to install weight sensor at the back of in the pavement head, and the weighing results is transfered into density, but the difference between the measurement results and the actual values are a little large. Most of the factories only take the measurement as a reference, and the density control mainly relies on the operators' experience. The most advanced testing equipment abroad is the sections densitometer manufactured in Germany GreCon Company, and the corresponding instrument StenOgraph can scan density structure on line, but the equipment is expensive and it is not suitable for the domestic original MDF production lines [7]. Therefore, it is of great significance to develop a density on-line measurement and control technology of MDF which is suitable for the domestic existing product line. At the same time, the MDF production line can be comprehensively upgraded and improved and the cost can be further saved. This paper will establish density on-line measurement and control hardware platform for multi-press machines based on single-chip computer and detection technology. Further more, a software system will be developed to make the whole process of detection and control of density automatically be completed.

2.Principle of Measurement and Control

Density measurement and control system is divided into hardware system and software system. The density test location is determined according to the actual MDF production line work processes. The automatic adjustment mode of the flow of the fiber is determined according to the working principle of fiber pavement equipment. Figure 1 shows the composition of MDF production line equipment and testing location.

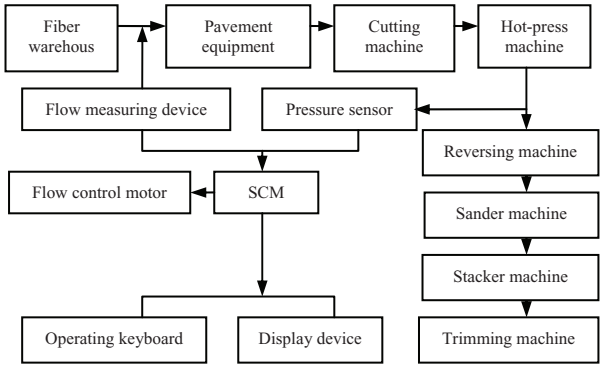

Figure1.Composition of equipment and measurement and control

2.1.Development of system hardware

System hardware mainly includes detection signal input divice, single-chip microcomputer, output drivers.

- *Detection signal input*

In the pavement equipment, because the screw feed mechanism is used, the volume of the feed screw device and the turn of the screw are of a certain proportion, and a mathematical model can be obtained after linearization. The thickness of the pavement or the capacity of fiber can be added through adding the turns of the screw device. Hall component is used here to measure the turns of the screw device, and then the square wave from the comparator is output into the SCM to count to measure the flow signal. According the weight of the board, the pressure sensors whose pressure range are not less than the maximum weight of the board are selected. The output voltage signal is digital-analog converted, and then is input to the SCM.

- *Output drive circuit*

The output weak signal from the SCM can not directly drive the motor of the screw feed mechanism, so a flow control circuit is designed to drive and control the motor.

The circuit can not only amplify drive signal, but also can control the turns of the motor, thus achieving the automatic adjustment of fiber transmission capacity.

- *Keyboard and display module*

The system key is set to 3, and complex combination methods are taken to compose keyboard functions. Software is taken to delay and cancel shake with the method of interrupting. System uses the section of code-type liquid crystal display, built-in display RAM, and can show any field stroke.

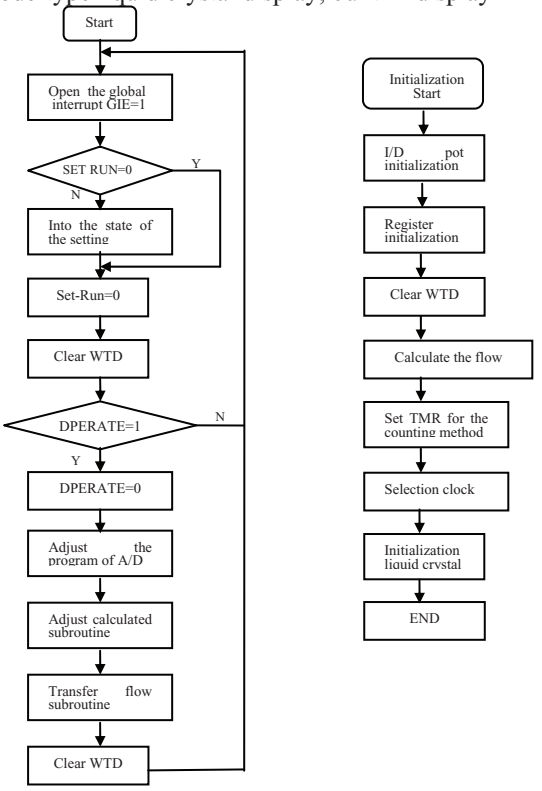

Figure2.The main program and initialization flow chart

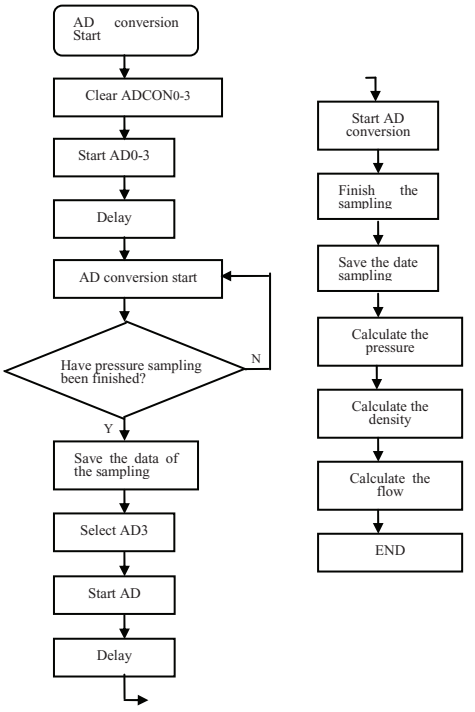

Figure3.A/D conversion process flow chart

2.2. Development of system software

The system has two working conditions: the running state and the setting state. The cumulative fiber flow, instantaneous flow rate and density value can be displayed when the system is in the running state. Parameters can be input and standard programming methods can be adopted in setting state. The main program mainly checks the critical few key query flag, and the appropriate subroutine is called depending on the circumstances to calculate the value of the collection and preservation. The main program flow and initialization flow chart are shown in Figure 2. Signal conversion process is shown in Figure 3.

3.Density Control

The MDF density of some MDF production plant ranges from 0.84 to 0.88 tones/cubic meter, 0.84 tons / cubic meter of density is set to the minimum, and 0.88 tons/cubic meter is set to maximum density. The

MDF of this plant basically accord with the maximum density in the production process to ensure the bonding strength and bending strength and a series of mechanical index in the past, and the density of a significant part of the products is more than 0.88 tons/cubic meter, which not only can not satisfy user needs but also caused great waste. Therefore, in this paper, the average density of MDF is set to 0.85 T/m^3 according to actual usage requirements. The density value is detected using real-time density detection device and compared with the set average of 0.85 tons / cubic meter, and when the density value of tolerance is above 2% three consecutive times or more than three times, the board is estimated as failure and the pavement flow should be adjusted.

4.Application

A production line of MDF plant is redesigned and the density on-line measurement and control system is installed with this method. Figure 4 shows the installation position of pressure sensor and Figure 5 shows the weight measurement of molding plate.

Figure4.The installation position of pressure sensor

Figure5.Weight measurement of molding board

A period of use demonstrates that the system has certainly achieved the desired purpose after the installation of the density measurement and control devices, as shown in Table 1.

TABLE I. COMPARISON OF DENCITY BETWEEN THE PRODUCTION LINE BEFORE AND AFTER THE DENSITY DETECTION DEVICE INSTALLED

Test date	**Product** substrate (mm)	**Yield of samples (m^3)**	**The yield of substandard density (m^3)**	**The yield of above standard density (m^3)**	**Comprehensive excessive production (m^3)**	**Of total production %**
3.16-3.30	12	5280	330	330	660	12.5%
5.20-7.10	12	3520	110	110	220	6.25%

The average density of board decreases 1.1% average, while the density tolerance ratio decreases from 12.5% to 6.30%, which meet users' needs better. Comparison analysis of actual weight and the weight of the display of the system shows that the system measurement accuracy reaches to 1.9% and annual average economic efficiency increase 1%.

5.Conclusion

The function of density dynamic detection and control can be achieved using the developed density MDF line measurement and control system. The operating interface is friendly and intuitive, and the data entry is easy modified and the density values can be real-time displayed. The system can alarm when the density is beyond the limit values. The designed feedback links can automatically adjust the fiber flow of the pavement equipment. The performance of the software and hardware is stable and reliable, and can effectively improve the MDF plant productivity and reduce costs. The work of this paper establishes the foundation of digital system MDF development for the comprehensive density detection.

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